

**REMARKS**

Claims 18-22 are all the claims presently pending in the application. Claims 18-22 have been amended to more clearly define the invention. Claims 18-22 are independent.

These amendments are made only to more particularly point out the invention for the Examiner and not for narrowing the scope of the claims or for any reason related to a statutory requirement for patentability.

Applicant also notes that, notwithstanding any claim amendments herein or later during prosecution, Applicant's intent is to encompass equivalents of all claim elements.

Claims 18-22 stand rejected under 35 U.S.C. § 102(e) as being unpatentable over the Iwamura et al. reference (U.S. Patent No. ,467,865).

This rejection is respectfully traversed in the following discussion.

**I. THE CLAIMED INVENTION**

The claimed invention, as defined by independent claim 18, is directed to a method for driving an ink jet recording head. The method includes applying a driving voltage to an electro-mechanical converter to deform the electro-mechanical converter to thereby change a pressure in the pressure generating chamber filled with ink, thus ejecting ink droplets with a size of about 5 to about 25  $\mu\text{m}$  through a nozzle in communication with the pressure generating chamber. The applying of the driving voltage includes a first voltage changing process which applies a voltage in a direction that increases a volume of the pressure generating chamber, a second voltage changing process which applies a voltage in a direction that reduces the volume of the pressure generating chamber; and a third voltage changing process which applies a voltage in a direction that increases the volume of said pressure

generating chamber again. The voltage changing times  $t_2$  and  $t_3$  during the second and third voltage changing processes have such lengths as shown below, relative to a resonance frequency  $T_c$  of a pressure wave generated in the pressure generating chamber being  $0 < t_2 < T_c/2$  and  $0 < t_3 < T_c/2$ . The nozzle has an opening diameter of about 20 to less than 30  $\mu\text{m}$ . The driving voltage changing times are based upon the resonance frequency.

In summary, while meniscus control may be known, an optimal driving voltage waveform for smaller volume of ink drops (i.e. approximately  $10^{-12}$  liters) in meniscus control did not exist until the present invention. The present invention utilizes pressure waves generated at nodes of the driving voltage waveform to eject a smaller volume ink drop in accordance with optimal rising/falling times of the driving voltage waveform.

Specifically, the present invention controls these pressure waves to eject smaller volume ink drops, by basing the driving voltage changing times upon the resonance frequency.

An exemplary embodiment of the present invention enables small drops by providing a rising time of a second voltage changing process to be less than  $T_c/2$ , adding a third voltage changing process, the falling time of the third voltage changing process being less than  $T_c/2$ , and the start time of the third voltage changing process being the end of the second voltage changing process.

## **II. THE PRIOR ART REJECTION**

Regarding the rejection of claims 18-22, the Examiner alleges that the Iwamura et al. reference teaches the claimed invention. Applicant submits, however, that there are elements of the claimed invention which are neither taught nor suggested by the Iwamura et al.

reference.

The Iwamura et al. reference does not teach or suggest the features of the present invention including a method for driving an ink jet recording head by providing a driving voltage that has driving voltage changing times that are based upon the resonance frequency of a pressure wave generated in the pressure generating chamber.

Rather, the Iwamura et al. reference is clearly directed to correcting the driving voltage in accordance with a viscosity change in the ink depending upon a change in the ambient temperature (col. 2, lines 44-49). While the Iwamura et al. reference only briefly discusses the concept of a natural frequency, it is only in relation with the nozzle size and the ink droplet size (col. 5, lines 24-35).

Therefore, the Iwamura et al. reference clearly does not teach or suggest the features of the present invention including a method for driving an ink jet recording head by providing a driving voltage that has driving voltage changing times that are based upon the resonance frequency of a pressure wave generated in the pressure generating chamber. As explained above, this feature is important for ejecting smaller ink droplets.

Therefore, the Iwamura et al. reference does not teach or suggest each and every element of the claimed invention. Therefore, the Examiner is respectfully requested to withdraw this rejection of claims 18-22.

### **III. FORMAL MATTERS AND CONCLUSION**

The Office Action objects to claims 20-22. This Amendment amends claims 20-22 in accordance with Examiner Nguyen's very helpful suggestions.

In view of the foregoing amendments and remarks, Applicant respectfully submits

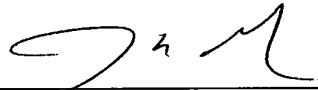
that claims 18-22, all the claims presently pending in the Application, are patentably distinct over the prior art of record and are in condition for allowance. The Examiner is respectfully requested to pass the above application to issue at the earliest possible time.

Should the Examiner find the Application to be other than in condition for allowance, the Examiner is requested to contact the undersigned at the local telephone number listed below to discuss any other changes deemed necessary in a telephonic or personal interview.

The Commissioner is hereby authorized to charge any deficiency in fees or to credit any overpayment in fees to Attorney's Deposit Account No. 50-0481.

Respectfully Submitted,

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